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November 20, 1994

Ms. Pam Innis
U.S. ENVIRONMENTAL PROTECTION AGENCY
713 SWIFT AVENUE, SUITE 5
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Dear Pam:

I am responding with the following comments on the Tri-Party Agreement Between the U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy proposed plan to build and operate the Hanford Environmental Restoration Disposal Facility (or ERDF).

First, I am in favor of a well designed landfill for permanent disposal of certian types of hazardous waste from the cleanup of the Hanford Site. However, I have concerns regarding the clay liner as designed. I think the clay liner may not be adequate to permanently contain dangerous radioactive and chemical waste. My concerns over the liner are:

1) The clay liner is shown in plans as only 3 ft. thick. Clay liners built for regular solid waste (household garbage) landfills are usually 5 ft. thick. I think the ERDF liner should be thicker for this massive landfill;

2) As shown in plan drawings for the ERDF, the terms "compacted clay liner" are used. However, the completed liner will actually consist of 91% sand and 9% sodium bentonite clay mineral (by wt.). The term clay as used by geologist, mineralogist, and soil scientist is applied to geologic materials composed of at least 51% clay content. Therefore, the term clay cannot be properly applied to describe the liner as shown in plan drawings. The proper term should be sand liner, or sand - clay liner;

3) With the clay content of the liner being only 9% with a total thickness of 36 in., means that if the compacted clay were separated as a pure layer (separated from 91% sand) it would be about 4¼ in. thick. The remaining sand would be 31.75 in. thick. This amounts to being a very thin skim coating of a clay layer to contain 70 ft. of waste materials, and;

4) Sodium bentonite clay used in the liner may be chemically altered over time with resulting degradation of its sealing performance.

Sodium bentonite is used in all the liners and containment barriers at Hanford. Sodium bentonite is also named na montmorillonite, Wyoming bentonite, high yield bentonite, and Western bentonite. Sodium bentonite is a member of the smectite group of minerals. The other montmorillonite clay minerals being: Calcium bentonite (ca montmorillonite, non-swelling bentonite, southern bentonite, and fullers earth), magnesium montmorillonite (saponite, armargosite), potassium montmorillonite (metabentonite), and lithium montmorillonite (hectorite). The structure of these clay minerals are extremely microscopically small aluminum silicate sheets with sodium, calcium, magnesium, iron, potassium, lithium, and other elements may be present. The particular montmorillonite mineral being named for the element which is dominant over the others as the principal exchangeable cation. The chemical and physical properties are determined by the cations present. The chemical and physical properties have a great variation between group members. The montmorillonites (or bentonites) are the best clays to use for sealing or liner applications because they are the least permeable to water. Also, these clays have a strong property of chemisorption, which is the ability to bond substances to the surface and between the silicate sheets of the clay minerals crystals. The sorption property will attract certian atoms, molecules, and even small particules like a magnet by electrostatic and other atomic forces and coat the clay crystals with a layer called the Stern layer. The sorption property will extract (or filter) certian dangerous chemicals and radionuclides as they very slowly percolate through the sand - clay liner in solution with water. The other clay minerals kaolinite and illite are much more permeable to water, and have weak to very weak sorption properties.

A thicker liner with a higher clay content would provide for more chemisorption capacity. I think that 4¼ in. of clay will not have enough chemisorption capacity for 70 ft. of overlaying waste materials should failure of the plastic liners occur. Moreover, I would like to see a clay subliner installed which is adequate to contain through sorption, the fullest capacity (or ability to sorb) as much of the radionuclides and chemical contaminates present in the completed landfill as possible. Because of even the slight chance that the pump and treat leachate collection could terminate in the future the landfill should be designed to take care of itself in the absence of human caretakers, and itself prevent dispersion of radionuclides and dangerous chemicals into the environment (or biosphere), rather than reliance upon indefinitely being pumped out.

Sodium bentonite is used as a sealing liner for landfills because it swells up greatly in size (or volume) with the absorption of pure water. Sodium bentonite mined from certian deposits will swell up to 20 x (times) the original dry size after saturation with pure water.

The swelling of the clay effectively seals pores in the sand - clay liner, and forms a very tight low permeability material. The sand in the liner is to provide physical stability and densification. The sand - clay mixture will compact easily whereas a purer clay is difficult to compact into a dense layer (or liner). The sand stabilizes against extrusion (flow or displacement) from the weight of the overlaying waste and landfill liner cap. If pure clay were used for the liner it will become plastic due to its rheological properties with the addition of enough water, and could flow or be displaced. A compacted dense sand - clay mixture of less than 10% sodium bentonite will not flow under pressure. Pure sodium bentonite saturated with pure water behaves rheologically as a watery gell, with strong lubricating properties. Also, hyaration pressures in montmorillonites may reach 2000 psi., because of these reasons the clay content for sodium bentonite - sand liners cannot exceed 10% or so.

Sodium bentonite does not swell (or expand) to the same volume in solutions of chemicals such as acids, alkalies, and saline solutions. The swell may be greatly reduced. Sodium bentonite does not swell in organics (such as oil), unless it is specially treated, as organoclay (organic clad clay). Bentonite clays are also subject to ionic exchange. The principal exchangeable cations can be removed and replaced by other cations present in solution, when the clay is placed into the solution.

I read in Hanford literature regarding a previously completed sodium bentonite liner that it would take "50 years for the waste water to pass through the liner". The liner was constructed (or built) to the same thickness (3 ft.) and permeability (1×10^{-7} cm/sec) specifications as the proposed ERDF landfill. Therefore, the liners are somewhat permeable, albeit slowly.

My point is that should something happen to human caretakers of the ERDF, so that the pump and treat leachate collection system would become abandoned, then chemicals in the waste will be passing through the liner. In a long time period the leakage will be significant. The chemicals and alkaline metals in the waste will interact with the sodium bentonite. The chemicals will cause shrinkage to occur in the bentonite by reducing its swelling or expansion, and that will cause an increase in permeability. Moreover, the actual clay mineral will likely be altered chemically into another montmorillonite clay mineral by cationic exchange with cations present in solution from the overlaying waste. Sodium cations may be leached by acidic or alkaline solutions and replaced by other matal cations, this too will cause an increase in permeability, because sodium bentonite has the highest swell volume of the montmorillonites,* and when altered to another montmorillonite it may be a low or non-swelling type (it may become a non-swelling clay).

Note: * Certian rare lithium montmorillonites will swell more than sodium bentonite.

If I may make a suggestion, I would like to see a non-swelling bentonite used in the liner. Non-swelling bentonite such as calcium bentonite, or nontronite (iron aluminum silicate) have chemical and physical properties that may be better in a liner application. The iron content helps bonding of certian radionuclides to the clay crystals. Calcium bentonites from certian deposits also have a high iron content. The impermeability of calcium bentonite will not be adversely affected by acidic or saline solutions as will sodium bentonite. Acidic solutions will remove some of the calcium cations, however, in doing so the edges of the sheet structure will be expanded around the edges and cause a slight swelling to occur. The slight swelling will tighten up the sand - clay mix resulting in decreased permeability. Saline solutions will further disperse any calcium bentonite clay aggragates to smaller particules which will cause a slight swelling, to seal-up the liner. Note, that this is the opposite effect as compared to sodium bentonite, which becomes more permeable when exposed to the same chemicals. Calcium bentonite or nontronite would have to be added in higher percentages to the sand to achieve the same impermeability (up to 30%). The greater amount of clay would provide for more sorption capacity. Calcium bentonite bonds the sand togeather more strongly than sodium bentonite in the moist state. Much more calcium bentonite may be added to the sand and still be stable against flow or extrusion. The clay is also less sensitive to the amount of water needed for compaction during the building (construction process).

Calcium bentonite liners (or sorptive barrier technology liners) are used at chemical plants in Texas, Mississippi, Flordia, South Carolina, and elsewhere. A hazardous waste landfill in South Carolina uses such a liner and cap, and not only to contain the waste but for backfilling around the waste containers in order to provide a sorptive medium for dangerous chemicals.

Sodium bentonite has been a standard at Hanford for years. I think that the EMDF is moveing ahead to fast to construction under the lets get the cleanup going attitude. This is one area where more time should be taken to test the liner materials performance over time before completing the main landfill at Hanford, its to big to not have as good as possible.

Finally, if I may I would like to outline a recent incident regarding plastic pipes in analogy to liners. I saw a report on CBS news about plastic water pipe. The pipe has become brittle due to exposure to chlorine in city water supplies. The pipe was in service for about 15 years, and then the pipes began to crack or split open. Water damage was estimated to be 800 million dollars in homes and buildings all over the U.S. The plastic in the pipes was made by major chemical manufactures who have been in business for a long time.

Sincerely,

Don Sivula

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